THE

Indian Tea Association.

SCIENTIFIC DEPARTMENT

QUARTERLY JOURNAL.

PART III.

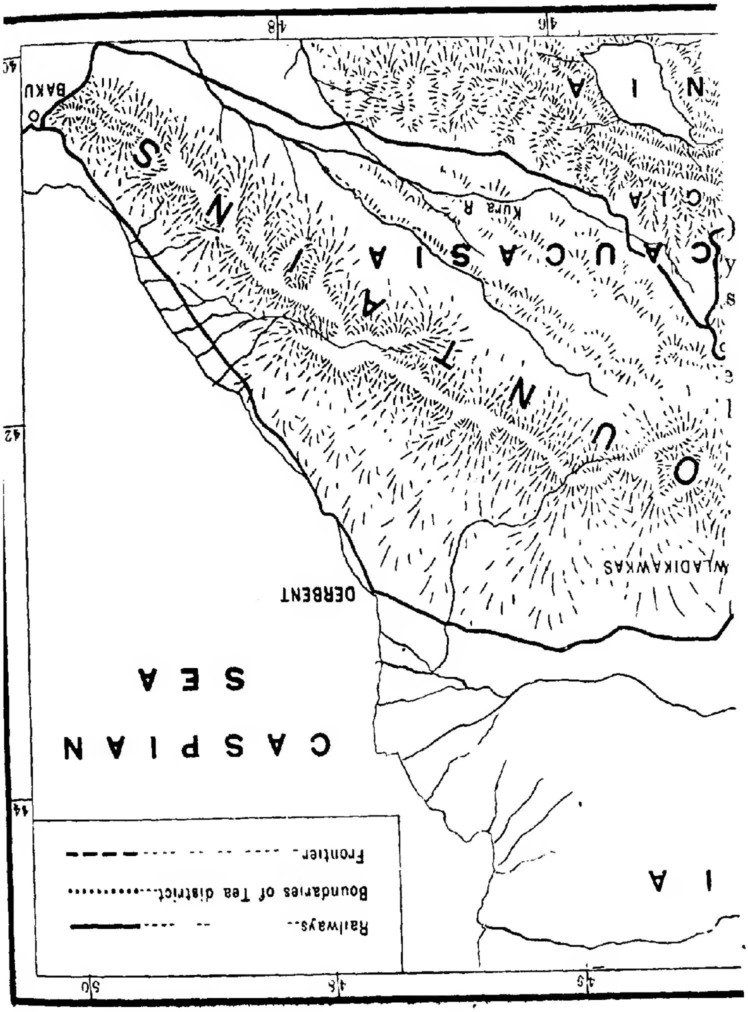
1914.

Calcutta:
PRINTED AT THE CATHOLIC ORPHAN PRESS.
3 & 4 Portuguese Church Street.

1914.

CONTENTS.

OF TRANS-CAUCASIAN RUSSIA.



…n, and on the east coast of the Black Sea, winter frosts are less

THE CULTIVATION OF TEA IN TRANS-CAUCASIAN RUSSIA

BY

G. D. HOPE, B. SC., PH. D., F.C.S.

The last issue of the Quarterly Journal (No. II of 1914) contained a short article on the cultivation of tea in the country immediate south of the Caspian Sea, in which a few observations were made regarding the soil and climate of that part of Persia.

This region is one among the very few lying directly to the west of the Himalaya mountains which have a damp sub-tropical climate. Most of such tracts are small in area, and, being surrounded by districts in which the climate is totally different, they have not developed important independent cultures suited to their particular climatic characteristics. The tract of country immediately to the west of the Caspian Sea—the land bordering its west coast—and the central part of Trans-Caucasia are too dry, and have too continental a climate to fall under the designation of damp sub-tropical. The land north of the Caspian is very dry. At Lenkoran on the south-west coast of the Caspian, north of Astara, (see the map in the issue of the Quarterly Journal above referred to) the rainfall is also too low to permit of the climate being called damp sub-tropical. It is 38 inches. Moreover there are droughts in summer and the temperature is so low in winter that the creeks near the shore are often covered with ice. North of Lenkoran the river Kura flows into the Caspian from the west through Tiflis, where it changes its course from northwards to westwards. The steppes of the Kura valley are more desert-like towards the east and in that part of Trans-Caucasia the temperatures are more extreme than in the west. Tiflis in the centre of Trans-Caucasia has winter frosts and a temperature sometimes as low as 7·6 F. and only 18 inches of rain.

However on the southern shores of the Caspian, as we have seen, and on the east coast of the Black Sea, winter frosts are less

severe and the rainfall is high. The latter district is as well suited to tea as the former, and it is one in which considerably greater progress has been made in its cultivation.

In this article I propose to give a general account of the natural features of this district nothing particularly such facts as have a bearing on the tract as one capable of producing tea.

The tea district on the Black Sea littoral can be defined more particularly as a belt along the east coast stretching from Ssuchum-Kale in the north to the Turkish frontier in the south and including the valley of the Rion river (see map). Many causes, chiefly climatic, combine to prevent the cultivation of tea being extended to any great distance inland beyond this zone. Attempts to do so have ended in failure. Ssuchum-Kale is apparently the northern limit to the tract in which it is possible to grow tea successfully. This tract corresponds roughly to the country known in classical times as Colchis. The Caucasus mountains protect this district from cold north-east winds, and their southern slopes condense the moisture carried by the winds from the Black Sea. Colchis has no definite climatic borders. At Noworossiysk and Tuapse, where the range is not so high, north winds blow in winter, and there is a Mediterranean climate. The rainfall at Noworossiysk is about 34 inches. At Tuapse it is 69 inches and a temperature of 14 F. is not uncommon. At Ssochi further south-east along the coast the rainfall is 80 inches, and the mean monthly temperature of the year varies between 80·6 F. and 59·54 F. The variation here is similar to that at Dehra Dun though the actual temperatures are a few degrees lower. Ssochi may be considered to be the beginning of Colchis proper. The country of Colchis is a land of forests, like the European coast of the Atlantic or the subtropical forest land of the east. Further south along the coast this feature becomes more pronounced. At Ssuchum-Kale which is the northern limit of the tea growing district, although the rainfall is somewhat less than 51 inches, the temperature is higner. The absolute minimum once only in 15 years reached 19·4 F. South of Ssuchum-Kale the mountains gradually leave the shores giving place to the broad Rion plain bounded on the north by spur of the Caucasus mountains (the Dadiani range) and on the

east by the Georgian-Immeretian hills which under the name of the Gurian range border this region on the south, approaching the coast again and extending south to the Turkish border.

The low plains through which the Rion flows, bordered by these hills, as well as the inner slopes of the hills themselves, can be called the central region of the Colchidian climate, the chief feature of which is its really damp subtropical character.

At Kutais, notwithstanding its comparatively continental situation, the mean winter temperature is 41 F. and that of summer 72·7 F. and the lowest minimum 15·6 F. The rainfall is 54 inches. Finally at Batoum on the sea coast the winter minimum is seldom lower than 23 F. and rainfall is over 90 inches. The following table gives the monthly variation in the maximum, mean, and minimum temperatures in Batoum during the years 1890, 1891 and 1892 :—

	1890.			1891.			1892.		
	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.
January ...	40·28	59·54	30·02	44·42	57·02	33·62	44·96	63·14	22·1
February ...	43·34	59·0	38·62	37·76	46·22	25·7	44·78	67·10	32·9
March ...	46·94	70·7	39·56	48 92	77·72	33·98	47·66	64·22	36·5
April ...	54·32	71·06	41·36	52·88	76·10	41·18	50·72	70·34	49·1
May ...	66·02	76·1	52·88	60·26	72·14	47·66	57·92	72·5	50·54
June ...	68·9	84·88	60·26	70·34	82·04	59·9	72·32	81·50	63·14
July ...	74·66	86·18	64·76	71·24	84·56	64·22	74·66	81·86	59·54
August ...	77·54	90·5	67·82	74·3	85·10	67·82	74·12	81·86	67·46
September ...	69·26	86·0	52·34	67·64	84 02	56·30	69·98	80·06	58·10
October ...	58·64	73·4	47·3	61·7	73·22	49·46	63·14	75·02	51·26
November ...	57·02	69·44	40·1	54·86	75·56	37·76	54·14	68·18	35·78
December ...	47·3	71·06	35·6	48·74	67·82	32·18	49·82	73·22	36·86
Average ...	58·68	74·78	47·13	57·75	73·46	45·81	58·68	73·25	46·94

At Poti the winter is warmer, the mean winter temperature being 44·1 F. although the absolute minimum is occasionally as low as 12·2 F.

Another table shows the quantity of rain which falls in each month of the year in some of the places mentioned :—

	Tuapsé.	Ssochi.	Ssuchum-Kale.	Kutais.	Poti.
January	3·8	8·5	3·6	5·2	5·2
February	7·9	6·8	2·8	4·9	4·4
March	3·9	5·8	3·7	5·3	3·2
April	6·2	4·5	3·1	2·8	3·2
May	3·1	5·0	3·9	3·0	2·4
June	4·8	4·2	6·0	4·5	6·1
July	8·1	6·6	5·3	4·0	6·1
August	6·5	7·0	4·3	4·2	9·5
September	5·2	8·9	6·6	4·1	9·0
October	3·4	6·6	3·9	4·1	5·8
November	6·2	6·3	3·4	4·1	4·6
December	9·9	9·6	3·8	7·3	5·9
TOTAL ...	69·0	79·8	50·4	53·5	65·4

Near Batoum July, August, and September are the rainies months. In April and May there are sometimes severe droughts Winter is wet, as in England, which has an Atlantic climate, and snow sometimes falls. The temperature however is not often many degrees below freezing point. Occasionally there is no winter to speak of. The rainfall is well distributed and the atmosphere is rarely dry except for short periods. The actual sun temperature is never very high.

In spite of the definite damp subtropical character of this district the climate has certain features which are not so favourable

as might be expected from the data we have given—a mean temperature of 59 F.* and abundant rainfall. The mean temperature of Batoum corresponds to that of the southernmost tea-producing districts of Japan, and there are but few districts in Japan and in northern China where the winter temperature is warmer. There are places near Batoum where the winter temperature is never lower than 32 F. or 30 F. The mean temperature at Ssochi is warmer than that of Tokio, the centre of the tea districts of Japan, and the winter minimum is only one degree lower. On the other hand the climate of Batoum is less subtropical than that of China and Japan in this respect that the summer maxima are not so high. In Colchis it is 84·4 F. and in Batoum not more than 74·3 F. In Hankow the summer maximum is 104 F. and the mean temperature in July and August is higher than 86·0 F.

Damp subtropical lands are separated widely on the face of the globe, and the climate of Colchis resembles that of Japan more closely than any other. Japan has, however, a monsoon climate and is hottest and wettest in summer. In Colchis in spring and summer it is comparatively cool and dry and the temperature is never higher than 75 F. The spring is cool and the autumn very warm. December is warmer than March. November is like April and October as warm as May, *i.e.*, between 59—61 F. In summer in Colchis there are heavy showers, but they are not very frequent and vegetation often suffers from drought. In Ssuchum-Kale where the rainfall is less the cultivation of such plants as tea and *Cryptomeria japonica* is hardly possible. So the climate of Colchis is not entirely analogous to that of the east of Asia though both belong to the damp subtropical type.

At Batoum the sea is colder than that which surrounds Japan and this tempers the summer heat. The climate of Batoum is intermediate between a damp subtropical, and a moderate maritimal one, but the growth of subtropical plants is possible. Summer

* The annual mean maximum temperature of Darjeeling is 58·5 F. minimum 47·5 F. the corresponding temperatures for the plains of India in the tea districts being about 80 F. and 65 F. respectively.

temperatures of Himalayan stations are lower than those of Colchis, and the winter minima are a little less than at Batoum.

The smaller variations of climate in Colchis are very peculiar. There are no regular seasonal changes of winds such as those caused by monsoons, and the direction of the winds depends very much on the orthographical peculiarities of the situation. The regular fluctuation in the temperature in the day time, and the differences of temperature between hills and valleys in winter and at night are the results of regular hill and sea breezes. At Batoum regular observations of these have been made. During the day there blows constantly a west-north-west wind tempering the heat of the day with damp sea air. After 6 p.m., there is an east-south-east wind bearing far over the sea air laden with the smell of swamps. These winds are not very strong. In the valleys where cold currents come down at night from high hills the night minima are lower than in places where the chief ranges are separated from the plains by lower hills. In such places morning frosts are often met with, and in winter, the sea being warmer than the land, the air currents are towards it, and the broad mouths of valleys facing the sea suffer from frost. Next to sea breezes the most important are western ones bringing continual rain. The weather depends on the movements of cyclones and periods of rainy days alternate with fine weather. Strong south winds sometimes appear in dry hot weather, which scorch young vegetation. Such winds are rare and are not experienced every year. At Kutais and in the Rion valley, open from the east, there are winds which resemble the *föhn* of the Alps. They are very dry. Ssuchum-Kale is protected against all the winds except the western ones, and though these do not bring so much rain here as at Batoum and Kutais, the distribution is better. The dampness of the air is a peculiar feature of the littoral of Colchis. At Batoum the average humidity is 85 and in summer 86. In Kutais it is 70. Further north at Ssuchum-Kale and Poti, and still more so at Ssochi, the air is less damp having more the characteristics of that of western Europe.

The district of Colchis has in consequence of its damp and warm climate the reputation of being very unhealthy, particularly to immigrants before they have become acclimatized. This reputa-

tion for unhealthiness refers particularly to newly cleared land and swampy districts.

What has been stated above with respect to the climate of various places in Colchis can be applied generally to the low plains between the sea and the hills which border the district, but there are considerable deviations from the figures we have given. Many protected southern and western slopes of hills have winter minima never below freezing point, and there are localities where the rainfall is well above the average. It is on such spots that subtropical plants are likely to grow most successfully. Careful observations have been made in several such places. As an example may be mentioned those relating to a place called Khalwastri which is in the district of Tschakwa, where tea is grown. This place is situated at a height of 2,952 ft. and has higher winter minima than Batoum. The maxima and mean temperatures are rather less owing to the elevation but the rainfall is four times as such. The winter minima fluctuate between 39·2 F. and 57·2 F. Elevated parts of Ssuchum-Kale and Ssochi have similar climates. The most suitable places for tea are consequently to be found at some height above the sea where the rainfall is higher and where the increasing tendency to a low temperature, dependent on the elevation, can be compensated for by choice of a situation protected from winds. For really subtropical plants, which require greater heat than tea, the high elevations are unsuitable, and the southern slopes of the low hills near the sea are the only places where they can be grown successfully.

Colchis falls geographically within the boundaries of lands which have a so-called Mediterranean flora. In Colchis, however, as we have seen, there is heavy precipitation during the summer months and indeed throughout the year and it is one of the rainiest tracts outside the tropics. The chief characteristic, however, of the climates in places where the flora is purely of the Mediterranean type is a small rainfall during the summer months, and in consequence of this the Mediterranean flora has developed in such a way as to be able to withstand drought. Typical Mediterranean flora consists of plants and bushes with leaves adapted to withstand

strong transpiration. A very good example of this type of vegetation is afforded by the myrtle.

But in Colchis, with another climate entirely, a very different flora has developed. Colchis is a land of marshes, ferns, and evergreen bushes, of epiphytes, lianas, and of such plants as require constantly moist conditions.

The distinguishing characteristics of a subtropical climate is a high mean and summer temperature, small yearly differences of temperature, no great cold in winter, and damp summer suitable to the development of many tropical plants. But with respect to both tropical and sub-tropical climates a distinction can be made between such as have heavy rainfall at all times of year and such as have a periodical dry and wet season. The climate of Colchis belongs to the first of these types but those of the Mediterranean districts and the monsoon districts of the subtropical India to the second. The climate of Colchis bears in this respect a relationship to that of the west coasts of Europe facing the Atlantic, *e.g.* Toulouse, and consequently, through its mean temperature is much higher, and the annual variation in temperature less, than the cold and foggy Atlantic coast, forest trees and many plants, ferns, and evergreen bushes, which are mostly western European in character, and not Mediterranean, flourish there.

The chief elements of the flora of Colchis are :—

(1) West European, and

(2) Caucasian and Asia Minor endemic

and there are very few typical Mediterranean plants, though the percentage of them is slightly higher than in the Atlantic provinces of the forest districts of western Europe.

It is interesting to note that some of the plants of Mediterranean type which appear in the district of Colchis are found only in the places where there were old Greek and Genoese colonies. Colchis too is rich in forms which spread further into Europe in Tertiary ages, and which have now either died out or occur only very sporadically.

The number of plant species in Colchis is not so great as in the far east but individual species often develop great size.

Maize is the prevailing food crop. Rice was at one time grown extensively but its cultivation was suppressed by the Russian Government as they feared it would make the district more malarious. Other important crops are wheat, barley, millet, rye, buckwheat beans, peas, lentils, luzern, cotton, hemp, safron, tobacco, potatoes, melons, pumpkins, and European vegetables. Among fruits of economic value figs, pomegranates, walnuts, cherries, peas, and mulberries may be mentioned.

Colchis can be considered as a continuation of the Atlantic nature of West Europe, and also, from another point of view, as a district in which there are still to be found a number of forms which are remnants of tertiary times.

Not only is Colchis a place in which tertiary forms have been preserved but it has been pointed out that tertiary flora was represented by similar forms all over the northern hemisphere, but now the so-called moderate zone has lost its tertiary vegetation under the influence of dryness and cold, and only preserves it in localities where it is protected against these influences. Therefore, the number of still preserved forms is proportional to the advantages of protection which exist in each locality. The subtropical species of Colchis differ more from the Mediterranean than they do from the forms of the far east, and many species are so similar to far eastern and Himalayan forms that they can be looked upon as but climatic variations of the same remains of tertiary flora in the east.

An attempt has been made to acclimatize Japanese plants in Colchis and trials made at Ssochi, Ssuchum-Kale and Tschakwa near Batoum have been highly successful. Tea has been sufficiently successful to have led to the establishment of tea planting as an industry and Japanese bamboos have been found to grow even better than in Japan.

The soils of Colchis are of many different types owing partly to the great variety of the rocks of the Caucasus mountains, and partly to some of the soils being sedentary and some transported, and to the differences in the processes of weathering which have taken place during their formation. In some places near the sea coast the soil has evidently a foundation of sea sand, in others of

delta alluvium brought down by rivers. The low hills of Mingrelia are composed of limestone, and the soils of the district consist in consequence of a yellow clay. Those of the Rion valley are alluvial. The soil of the upper part of the valley are generally gravelly, but lower down they are sandy and contain many mica particles. The Rion river brings down a quantity of mud. The slopes near Ssochi and Ssuchum-Kale have heavy clayey soils, a feature which is common to most of the Black Sea coast. Some of the soils there contain a considerable quantity of lime and appear for this reason to be unsuitable for tea culture. Manganese mines exist in Colchis and the soil probably contains a fairly high percentage of manganese. This is a feature common to a great many tea soils in different parts of the world. The red brown soils round Kutais and still more the bright red soils of Tschakwa in the Batoum district remind one of the lateritic soils of subtropical districts and they all have the same chemical features *i.e.*, high iron content and scarcity of lime and alkalis. The same geological formations give rise in the upper part of the hills not to lateritic but to sedentary soils of a stiff clayey character, and the difference between these and the lateritic soils is due to the difference of climatic conditions under which the weathering of the rock has taken place. Where laterite formation takes place the hills do not present sharp peaks and angles, but have usually, a smooth rounded outline. This is a distinctive characteristic of the hills near Tschakwa.

More porous soils are only to be found among those which are alluvial.

The following is a chemical analysis of a compact lateritic clay soil from this district :—

Nitrogen	·22
Potash	·10
Soda	·25
Magnesia	1·79
Lime	2·64
Phosphoric acid	·16
Alumina...	25·10
Iron	6·99
Insoluble in acid	54·37

The soil differs very considerably from the tea soils of North East India particularly in its high lime and alumina content.

The percentage of lime in this case is much higher than is typical of lateritic soils.

The mechanical composition of a soil from a Batoum tea garden is as follows :—

Moisture	5·24%
Soluble in acid	1·14%
Coarse sand	27·57%
Find sand	12·55%
Silt	23·56%
Fine silt	7·44%
Clay	22·50%
Organic matter (by ignition)	16·52%

This soil differs from those of the North Persian tea districts (see the previous number of this Journal) in containing more coarse sand and less silt and it is distinctly of a heavy loamy character.

On visiting this district I was able to obtain much more accurate information that was possible in Persia. I had the good fortune to meet Professor Krassnow the Director of the Botanical Gardens in Batoum, the Director of Botanical Gardens in Ssuchum-Kale, and the manager and assistant of tea gardens belonging to the Imperial Domains at Tschakwa near Batoum.

Professor Krassnow visited Kangra and Darjeeling in India, Japan, China, Java, and Ceylon some 25 years ago in order to study tea culture, with an expedition which went to obtain seed and specimens of tea. The leader of this expedition was an agriculturist named Klinger.

The original idea of the possibility of tea cultivation in Colchis appears to have belonged to Prince Vorontsoff who in 1847 had some shrubs brought from China and from the imperial Nikitski gardens in the Crimea and planted in Ozurgeti. Afterwards between 1850 and 1860 the shrubs were removed from here, partly to prince Eristoffs garden near Chahaturi in the same district and

partly to the estate of the Prince of Mingrelia in Zugdid district. In 1861 the attempt was made to prepare tea but the product was very poor owing to lack of knowledge of the best methods of manufacture.

In the meanwhile tea bushes were found to flourish very well in the botanical gardens at Ssuchum-Kale, and from the seed grown there as well as from the garden of Prince Alexandra Michailowich, a small plantation was started over 25 years ago. This produced tea of fair quality.

Then some plantations, established by Mr. Popoff and situated near Tschakwa in Kaprishun and Salibauri, gave good results. Mr. Popoff visited China himself and brought good plants back with him, and he also introduced hybrids and Assamese shrubs. His plantations were placed at various elevations which made it possible to learn something about the most suitable situation for tea in this district.

Experiments in acclimatization showed that hybrids do not suffer at the low temperatures of winter on the most favourably situated gardens and that in this district as in India they flush better than pure China bushes. They suffer from frost however at the higher elevations. It appeared also that pure Assam varieties can grow well, though it is doubtful whether they are suitable for the climate because they suffer considerably in winter and lose their leaves. They are not cultivated any longer for this reason. Above 1,000 ft. all varieties suffer from frost. The varieties which appear to have survived the experimental stage of acclimatization are pure China, and hybrids from Kangra and Ceylon.

The seed originally experimented with was as follows :—

(1) from plants imported from China :
(2) from Hobaz near Hankow :
(3) from Japan—these did not give good plants though the seed itself was good. This variety has therefore been abandoned :
(4) from Kangra valley hybrids :
(5) from Darjeeling—a few seeds of hybrids :

(6) from Ceylon hybrids:
(7) from Assam—the plants from this seed suffered from frost and are not grown any longer.

It is of course a very great drawback to these estates that China and poor hybrids alone appear to flourish there and this fact is not sufficiently realized there. For the past 15 years scarcely any new seed has been imported into the Batoum district, and the seed for all new clearances has been obtained from older tea estates in the same locality. It would be worth while to investigate once again the suitability of various hybrids and indigenous varieties, for much more is now understood about the general methods of treatment of tea than was known when these experiments were undertaken.

New clearances are often planted up with seed at stake, 3 or 4 seeds being placed together. The seeds are sown soon after being collected. In these districts seed bushes flower in August and September and the seeds are ripe in October of the following year. Where nurseries are made the seeds are sown one inch deep and three to seven inches apart, and the young plants first appear above ground in April, having been planted in October or November of the previous year. They attain the height of about seven inches at the end of the first year. In the winter they are covered with dry branches or bracken to protect them from frost. In the next year they are planted out and reach a height of from four to six feet. Apparently during this year the bushes are plucked, that is, before they even receive their initial low pruning. This is of course a procedure which calls for criticism unless it is done with a thorough knowledge of the principles of plucking and pruning and in order to promote the formation of properly shaped bushes.

The estates which I saw are situated on sloping ground between low hills and the sea. The soil is composed of the red lateritic clay above described. There are no terraces or any other form of protection from wash. Terraces have been tried and the wash was found to be considerable and they were abandoned. This was probably on account of the long period of time which there is between the planting out of the young bushes and their developing

sufficient breadth to cover the ground. There has been no attempt as far as I saw to prune the bushes scientifically, or in any way to train the young plants into proper bush form. The result is that they are very poorly developed and have no width to speak of. Plucking is not done according to any fixed system and consists merely of taking off two leaves and a bud wherever and whenever they develop. Cultivation is not carried out on a very liberal scale. Consequently the crop is very small—250 lbs. per hectare *i.e.*, about 100 lbs. per acre.

Albizzia julibrissima, a leguminous tree very similar in growth and general appearance to the sau tree (*Albizzia stipulata*), is grown as a shade tree and appears to flourish well here. It is indigenous to the province of Mazanderan in North Persia. Its flowers are pink.

The tea bushes do not apparently suffer seriously from pests and blights.

The caterpillar of the moth *Agrotis suffusa*, a cut worm, damages the stems of young plants, and a mole cricket attacks seedlings, and boring caterpillars do considerable damage. A little red spider occurs, and a black fungus is found on the leaves.

The first instruction in the manufacture of tea in this district, was given by Chinamen who were brought here some twenty-five years ago for the purpose. A Chinaman still superintends the manufacture of tea in the factory attached to the Imperial Domains.

At one time a Ceylon tea planter was employed.

At present endeavours are being made to obtain an Englishman with experience of tea planting in India to control the manufacture of the tea in this district.

The manufacture is carried out in a small well-equipped factory. Several features in this factory could be easily improved, although an effort has evidently been made by the capable Chinaman who manages it, to work on modern lines.

The withering is done partly in the sun on a large cement floor in the open, and recently a withering house has been built in which leaf is withered during wet or damp weather. In this building the leaf is withered on wire by air which is drawn by

fans, and artificially heated in a separate chamber by means of steam pipes. This is an advance on our methods of withering by heated air, where artificial withering is resorted to—because in North East India only the exhaust air from drying machinery is used for this purpose, and such air already contains a large quantity of moisture.

The rolling is carried out on Jackson Metallic Rollers of fairly modern type. No attempt is made to keep the leaf cool in rolling and the rolled leaf which I saw when I visited the factory was very hot. The fermentation was carried out on trays and the leaf was spread in undesirably thick layers, and was consequently at too high a temperature. The cleaning and sorting of the tea call for no particular comment and were not very carefully done. The factory however is very clean and it is evidently to want of knowledge of the small details of garden and factory work, wherein the secret of a good crop and manufacture lies, rather than to lack of enthusiasm on the part of the staff, that the poor results as regards both outturn and quality are due. With improvement in outdoor and factory operations, I feel confident that very much better results could be obtained. A factory is also attached to Mr. Popoff's estates and a second factory for the tea estates of the Imperial Domains is being erected.

Good Tschakwa tea sells at 1½ roubles, *i.e.*, 3/3 a lb. A China tea of similar quality can be bought for 2 roubles, *i.e.*, 4/4 a lb. No duty is paid on tea produced here which of course affords a monetary advantage equivalent to a heavy bonus to the producers. Indeed this alone makes it possible for tea planting to pay on the lines on which it is at present conducted in this district. It is however Dr. Krassnow's opinion that it might always prove to be a profitable industry if it were carried out as it is by the peasantry of China and Japan and the indigenous population of Java, instead of the attempt being made to work on the lines adopted in North East India, Ceylon, and Java, *i.e.*, large estates capitalized by public companies or wealthy proprietors.

Apparently when the possibilities of tea as an industrial enterprise for the locality was first realised it was thought that

the best chances of success lay in establishing it as a native culture. When I visited the district, however, I heard nothing about this, and all the tea spoken of consisted of considerable estates belonging to wealthy individuals or to the Imperial Domains.

It is now an established fact that, in spite of the high wages demanded by labourers in the district, these estates can—with the great initial financial advantage afforded by freedom from payment of the import duty of about 1/10½ per lb.—make good profits.

The cost of clearing land is high and amounts to about a hundred roubles per dessiatine—a rouble being worth about 2/2 and a dessiatine being 2·7 acres, *i.e.*, about Rs. 60 per acre. The daily wage of labourers is also very high. Pluckers get 60 to 70 copeks, *i.e.*, 15 to 18 annas and tillers about 1 rouble. In comparison with nimble figured Indian coolies or Chinese the labourers pluck very slowly. The labour consists of settled Georgian and Greek villagers and nomadic Kurds. These last work well and are reputed to be honest. In winter there are less attractions elsewhere and labour is cheaper and more plentiful.

There are I believe about 500 dessiatines *i.e.*, 1,350 acres of tea at Tschakwa. 200 dessiatines *i.e.*, 540 acres near Batoum and 50 to 60 dessiatines *i.e.*, 130 to 160 acres in land near Kutais.

GREEN MANURES

BY

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AND

A. C. TUNSTALL, B. SC.

COWPEAS.

Cowpeas.—*Vigna catiang*, Endl. (*Vigna sinensis* of modern American authors) :—For a long time this plant has been made use of as a green manure for field crops and lately it has been employed successfully for tea. It somewhat resembles Mati kalai in appearance but the growth is much more rapid and the leaves are larger. The flowers are small and white, and are produced in clusters. The seed pods are long, and instead of hanging down as pea or bean pods do, they stand erect. The flowers are produced about twelve weeks after sowing. The plant is a climber but when growing on fairly good soil it does not commence to twine until it is two or three feet high. This height is attained under normal conditions about three weeks after sowing and at this time the weight of organic matter contained in the crop equals, if not exceeds, that produced by a good crop of Mati kalai. If growth is allowed to continue the tea bushes will be completely covered with a dense mass of twining stems. It is therefore important that the crop be sickled or hoed in at the proper time. Cowpeas will grow at any time of year provided that there is sufficient moisture in the soil for the germination of the seed. The most luxuriant growth is obtained during the early part of the rainy season, but cold weather crops of cowpeas also give a large amount of organic matter. Twenty-five seers of seed is sufficient for an acre of tea. If the plant is sown for seed considerably less should be sown per acre, as each plant when full grown completely covers more than a

square yard of ground and six or seven seers is ample. Good crops of seed are obtained if the cowpeas are sown at the beginning of the cold weather.

Peristrophe Bicalyculata.

In the Planters' Chronicle of Southern India published April 19th, 1913 mention was made of *Peristrophe bicalyculata* as a possible green manure plant for tea. A small quantity of seed was obtained from Southern India last year, and sown on very poor soil at the Tocklai Experimental Station. It grew very luxuriantly producing bushes 5 to 6 feet high. The principal lateral stems arise from near the ground and grow out horizontally for about nine inches before turning upwards. Rootlets arise at the base of these stems, so that a single plant covers the soil very well. The leaves and stems are covered with hairs giving the plant a greyish colour. Small rosepink flowers are produced. The seed is minute and the amount per acre required would be very small. Five seers is suggested. The plants on the experimental plot seeded in November last, and then died. As the soil was not required at once it was not hoed up. In the following April a self-sown crop of *Peristrophe* appeared not only on the plot but also on the surrounding soil. This has since grown luxuriantly. It would appear therefore that this plant is well suited to the conditions which obtain in Assam.

It is not a leguminous plant but belongs to the *Acanthus* family. The following is an analysis of *Peristrophe* plants grown at Tocklai :—

		Leaves.	
		Calculated on the dried plant.	Calculated on the fresh plant.
Organic matter	...	81·57	52·36
Nitrogen	...	3·69	2·37
Lime (CaO)	...	3·60	2·31
Magnesia (MgO)	...	2·10	1·35
Potash (K_2O)	...	1·55	1·00
Phosphoric acid (P_2O_5)	...	·61	·39
Water	...	...	35·80

STEMS.

	Calculated on the dried plant.	Calculated on the fresh plant.
Organic matter ...	95·85	41·51
Nitrogen ...	1·33	·58
Lime (CaO) ...	·40	·32
Magnesia (MgO) ...	·30	·16
Potash (K_2O) ...	·93	·40
Phosphoric acid (P_2O_5) ...	·55	·24
Water ...	...	56·69

ROOTS.

	Calculated on the dried plant.	Calculated on the fresh plant.
Organic matter ...	94·41	38·52
Nirogen ...	1·17	·48
Lime (CaO) ...	·49	·20
Magnesia (MgO) ...	·26	·11
Potash (K_2O) ...	·98	·40
Phosphoric acid (P_2O_5) ...	·43	·18
Water ...	...	59·20

Calculated on the whole fresh plant.

	Leaves.	Stems.	Roots.	Whole plant.
Organic matter ...	1·31	30·09	9·63	41·03
Nitrogen ...	·06	·42	·12	·60
Lime (CaO) ...	·06	·23	·05	·34
Magnesia (MgO) ...	·03	·11	·03	·17
Potash (K_2O) ...	·02	·29	·10	·41
Phosphoric acid (P_2O_5)	·01	·17	·04	·22
Water ...	8·95	41·08	6·76	56·79

FUNGI PARASITIC ON THE TEA PLANT IN NORTH EAST INDIA

BY

A. C. TUNSTALL, B. SC.

Part IV.

ASCOMYCETES—(*continued.*)

COPPER BLIGHT.

Laestidia thea, Racib.—This blight is most in evidence about the time the second flush of leaf makes its appearance. At this time one frequently sees, especially on large-leafed varieties of tea, numbers of leaves bending over in a peculiar manner. A closer examination of these leaves usually reveals a pink or coppery sheen on the under surfaces. Many theories are advanced to account for this condition; some planters put it down to the sun: others to the wind. Microscopic examination however shows the presence of fungus mycelia in the surface cells of the leaf causing an alteration in their size which makes the diseased leaf bend over. At a later stage the fungus attacks the underlying cells and the leaf straightens out again. Bright brown patches then make their appearance. Later these bear numbers of minute black dots irregularly scattered in the neighbourhood of the leaf veins. These are so small generally as to escape observation. A lens shows these dots to be crater-like openings with irregular edges. The black dots are the openings of the pycnidia or cases in which the conidiospores are produced. These pycnidia are succeeded by a second kind of fruiting body, the perithecia, which contain ascospores. The openings of the perithecia closely resemble those of the pycnidia but the patches on which they are produced are usually of a greyish colour resembling those produced by Grey blight.

The life history of the disease may be summarised as follows :—

1st stage	...	Coppery sheen usually accompanied by the bending over of the leaf.
2nd stage	...	Bright brown patches bearing pycnidia.
3rd stage	...	Greyish patches bearing perithecia.

Copper blight may easily be confused with Grey blight and Brown blight. The black dots of Copper blight differ from these produced by Grey blight (*Pestalozzia palmarum*) in the following respects :—

1. They are much smaller.
2. They are irregularly scattered while those of Grey blight are usually produced in concentric rings.
3. The openings are irregular and not provided with a definite edge like Grey blight.

Copper blight is readily distinguished from Brown blight (*Colletotrichum camelliae*) by the colour of the patches, Copper blight patches being a much brighter brown than those produced by Brown blight. No black dots are visible at any time on the latter. It is frequently observed that Copper blight is more noticeable during periods of drought succeeding heavy rain than at other times. For this reason planters commonly attribute the work of the disease to the hot sun, which undoubtedly hastens the development of the fungus causing the leaves to turn brown quickly.

On the first appearance of the disease all affected leaves should be removed and burned and an application of Bordeaux mixture should be made. A week to a fortnight later a second application is desirable.

During the rainy season very little can be done to check this disease if it has been allowed to become general. It is least in evidence during the cold weather and in cases of general infection, at that time of year, the following treatment should be carried out:

1. After the bushes have been pruned all spotted leaves should be removed. These should be buried or burned with as little delay as possible.

2. An application of soda solution (ibid. p. 48, part II, 1913) should be made before the new shoots appear.
3. After the first flush has been plucked, Bordeaux mixture (ibid. p. 79, part III, 1913), Woburn Bordeaux paste, or lime sulphur solution should be applied.
4. If the blight is still serious another application of spray fluid should be made after the first flush has been removed.

It frequently happens that although the distribution of the Copper blight is general, the blight is not sufficiently serious to warrant the adoption of the above treatment for its own sake alone. It should be noted however that the above treatment will not only remove the Copper blight but also many other minor blights which are doing their share in reducing the outturn. Moreover the bushes will in any case be stimulated by the solutions applied.

ADDRESS TO DARJEELING PLANTERS.

At an Extraordinary General Meeting of the Members of the Darjeeling Planters' Association, held on 8th August 1914, Dr. G. D. Hope, the Chief Scientific Officer of the Indian Tea Association, addressed the Meeting as follows :—

My tour last cold weather in Java, Ceylon, and Sumatra, about which I have already had the opportunity of telling you something, brought before me very clearly the great differences which exist between the conditions in this tea growing district and those which obtain elsewhere, and gave me certain ideas as to how such different conditions must modify garden work. Mr. Tunstall's experience of the different tea growing districts of North-East India have impressed the same facts on his mind. Consequently, when drafting the programme of the work of the Scientific Department for this year I thought that it might be of use if we were both to meet you here in order to present to you a joint address embodying suggestions as to modifications and improvements, which we think might be made in order to counter-balance some particular disadvantages which are due to your climate and situation.

I need not discuss wherein the differences in condition lie nor their cause, they are sufficiently well known to you, but I will pass on at once to make certain practical suggestions about pruning and manuring and Mr. Tunstall will then discuss the question of spraying.

In discussing pruning in this district as it may affect the bushes in their present indifferent condition, it may be of value to compare the methods adopted here with those carried out in the plains of India and in districts of similar elevation in Java and Ceylon, taking into consideration the effect which climate may exert in each case.

It is hardly necessary to draw attention to the difference between the growth of bushes in this district and in the plains,

be it in the Dooars, Terai, Assam, Cachar, or Sylhet. In both cases the definite cold weather, accompanied by drought in the winter months, and later, in the spring, when the temperature is higher, drought alone, causes a cessation of growth for several months. Apart from this the mean temperature of the district is a controlling factor in the total amount of growth. The mean temperature of places in this part of India, though it cannot be so closely correlated with their height above sea level as in Java and Ceylon, is nevertheless roughly dependent thereon. Consequently at lower elevations and on the plains the total growth of bushes is greater than at higher elevations, on account of the higher temperature.

In Java, at the highest elevations where tea is grown, bushes are pruned once in about two years, at lower elevations more frequently. Pruning is there carried out at all seasons for there is a comparatively uniform climate through the year, but an effort is made to confine it as far as possible to the short but definite periods of dry weather which occur at different times, for then less growth is taking place and there is less likelihood of the cut surfaces of branches bleeding after pruning. This is very much the method adopted in Ceylon but there, at the highest elevations, where the temperature is low and growth consequently slow, for example on the tea estates in the neighbourhood of Nuwara Eliya, the period between successive prunings may be as long as four years.

In these two countries there is no definite cold weather such as is experienced in India, and droughts of sufficient severity to check the growth of bushes are of comparatively short duration. The bushes are consequently in a state of more or less active growth all through the year, and though probably the rate of growth is never at any one time so rapid as it is at the most favourable times of the year in the plains of North-East India, nor, probably, so rapid at places of the same elevation as it is at certain times of year in this district, yet the total growth throughout the year is in most cases, and certainly at the higher elevations, greater than in places of like elevation in India.

We are thus led to the conclusion that the total annual growth of tea bushes in this district is less than at similar elevations in

Java and Ceylon, and very considerably less than in the gardens in the plains of India. A comparison of crop returns and a knowledge of the amount of growth removed in pruning is alone sufficient to demonstrate this fact.

And yet in this district, although probably in most cases a larger percentage of the whole area of estates is left unpruned each year than on estates in the plains of India, pruning is carried out with twice to four times the frequency with which it is done on gardens at similar elevations in Java and Ceylon.

After careful consideration of the relative climatic conditions under which tea is grown in this and other districts, I have come to the conclusion that successive prunings of bushes are carried out on the estates at high elevations in the Darjeeling district, more frequently than is either necessary or desirable.

There are of course exceptions to this general statement, for I know of several gardens where a third or more of the total acreage is left unpruned in each year. This procedure is to be commended at high elevations.

Too frequent pruning is weakening to the bushes themselves and accounts I think largely for the relatively poorer development of wood on bushes here than in other districts and for the immeasurably greater harm done to the bushes by pests and blights.

This is not the occasion to repeat the arguments which are put forward fully in a pamphlet on "Some aspects of modern tea pruning" which is about to be published, because I hope that you will consult our views on pruning as expressed therein, in connection with what I am now saying, but I must emphasize particularly here, in this district, that pruning, necessary as it is as a garden operation, weakens bushes, and in districts where owing to climatic influences growth is naturally slow, pruning should be carried out less frequently than in districts where wood removed in pruning is replaced more quickly.

I think therefore that a system should be adopted for high elevation gardens of leaving bushes unpruned in alternate years and alternately light pruning and cleaning or thinning them out in the years when they are pruned. In lower elevations bushes

should be left unpruned once in every third year, top pruned with thinning or cleaning out in the following year and light pruned in the third year.

Such systems, or modifications of them, would I believe be admirably suited to Darjeeling conditions, if concurrently spraying and heavy manuring were carried out as part of the general garden work.

The advantages which would follow such systems are several.

In the first place the plucking throughout the year is always more easily controlled and the production of the crop better distributed when a considerable part of the total area of tea is left unpruned, for the unpruned tea yields the bulk of its crop early in the season and then the pruned bushes can be allowed good growth before being regularly plucked, and towards the end of the season when the unpruned tea has yielded its crop the attention of the labour force can be devoted to the careful plucking of the pruned tea.

The most decided advantage however from leaving a large area unpruned is in connection with the general strengthening of the bushes and the thickening up of the shoots which are going to be pruned at the end of the year. This is the all-important question in this Darjeeling district.

In considering how the remainder of the area should be pruned I must again draw attention to the pamphlet on pruning which I have just mentioned. When you read it you will at once recognise that it was not written with special reference to the conditions which generally obtain in this district but that it refers more particularly to the pruning which is possible on well-laboured gardens in the plains where the bushes are healthy and vigorous and free from pests and blights. However, the principles of pruning laid down in this pamphlet apply to all tea bush pruning, and it is my object in addressing you now, and my duty, to point out to you how these principles can be adhered to in practice in this district so as to give the best results. This necessitates certain modifications of the methods which we have suggested for pruning on estates in the plains.

In the first place as I have said, pruning should be carried out less frequently.

Secondly when pruning is carried out the object should be to produce fewer but stronger branches than are usually found on bushes in this district. The methods of pruning which are described in the pamphlet I have alluded to under the names of thinning out, spacing out, and cleaning out, are of special value in reducing the attacks of pests and blights, and the reason for this lies in the greater vigour of growth which is developed by branches of bushes which have been pruned in one of these ways, and this increased vigour of growth is the result of less competition with other branches and twigs for available nourishment. The importance of carrying out one or other of these methods of pruning where possible cannot be over estimated, and if carried out they will tend to reduce the attacks of pests and blights and will also make heavy pruning less often necessary.

This Department has been charged with advocating as an isolated policy quite unconnected with any other garden operation, heavier and more drastic pruning as a remedy for the innumerable pests and blights which occur on the tea in this district. This is not so. No recommendation with regard to any particular garden operation would be put forward by officers of this Department without carefully considering what modifications of other garden operations might be necessary as the result of it. What this Department does suggest is that pruning in this district requires modification in two directions.

Firstly pruning should be carried out less often, and secondly when it is carried out it should be done more carefully, if necessary more expensively, and certainly more scientifically. Moreover the bushes which are pruned in this way should be manured and sprayed so as to invigorate them as far as possible and enable them to replace numberless useless twigs by a few really useful healthy branches.

Given vigorous bushes spraying and pruning are the two chief direct means of keeping them free from attacks of pests and blights, but as the pruning which I have indicated as being that

best adapted to this end cannot be carried out, for reasons I have given, so frequently in this district as elsewhere, spraying as an additional means of keeping bushes in a healthy condition should receive greater attention here than in districts where clean pruning can be carried out regularly and frequently. Mr. Tunstall will deal with the question of spraying in its practical details when he addresses you.

This Department, then, puts forward the methods I have just referred to as the only practical policy to adopt to improve what must be admitted to be the very unsatisfactory condition of a great deal of the tea if not of whole estates in the Darjeeling district. I quote Ceylon as an example of what extensive and expensive manuring can do, combined with reasonably good, though by no means intensive, cultivation and careful though by no means scientific pruning. Similar results might be expected in this district if we were to go in for a system of heavy manuring, as good cultivation as labour conditions permit of, spraying, and really scientific pruning, with a proper understanding of the interdependance of these operations. The necessary labour for the last operation would be available if the area pruned in each year were limited.

Though I am making a statement which I know to be contrary to the opinion of several leading planters in this district, I register it emphatically as the opinion of this Department that the extensive use of manures of all kinds, including imported artificials would tend very largely to reduce the prevailing damage done to bushes by pests and blights.

The use of manures is I believe feasible and is urgently required in this district and will come about sooner or later. Manures are being increasingly used on all go-ahead estates in Assam with results which put aside all doubt as to their general usefulness.

Those who differ with us in this opinion bring forward arguments which are not without considerable weight to support their contention that manuring with artificials can never pay in this district. They speak of the cost of the manures themselves, of the

heavy freight, of the cost and labour involved in applying them, of the effect applications of manures may have on the growth of jungle, already prolific enough on most estates. They argue that large expenditure per acre cannot be incurred on tea which is at present giving only a small profit per acre, and so on.

Against these arguments I would bring forward the following counter arguments.

There is no tea district I have seen in India or elsewhere where the bushes have such feeble growth, or are so obviously weakened by pests and blights as the Darjeeling district. The fault of this lies not entirely with the climate and soil. It is largely due to neglect in the past but partly I think to incorrect and inadequate treatment of the soil and bushes now, though this is becoming less so every year, and garden work is being improved in every direction.

In Ceylon at similar elevations bushes are incomparably more vigorous and this is not due to better cultivation or to more careful prevention of loss of surface soil by wash, for the former is if anything inferior to what is done here and neglect of the latter has been one of the most obvious and disastrous mistakes in Ceylon planting, but, it has been due to the extensive and intensive use of manures combined with a proper understanding of the effects of pruning at different elevations. Since manuring has become general in Ceylon pests and blights with but few exceptions have done comparatively little harm.

In Java the bushes are likewise much more vigorous than in Darjeeling and though manuring has not been a factor in this case, this is no argument against the use of manures in this district for the Java planter has from the very first realized the importance of retaining his rich surface soil and has done admirable work with this end in view and continues to do so.

In Ceylon where manures are used at high elevations, freight is a factor of considerable importance but the use of manures is not checked thereby. I have figures which show that in this district the freight paid on manures would add a very few annas more to the cost of manuring per acre, than that paid at similar elevations in Ceylon.

Increased cultivation and the carrying out of expensive work directed towards the prevention of wash would undoubtedly go very far towards bringing about the results which we wish to obtain but this is not the time for bringing forward any suggestions for garden work which are so directly dependant for their execution on the total amount of available labour. The paucity of labour and therefore of means for carrying out intensive or even adequate cultivation on many Darjeeling Estates is one of the strongest arguments we can bring forward for the use of other means of increasing the vigour of bushes—means which do not necessitate the employment of so large a quantity of labour as would be required to bring about the same result by cultivation alone.

Labour is scarce but money for the purpose of manuring would be readily available once the necessity for and value of manures were recognised.

Finally if manuring gives the results it has given on tea estates elsewhere,—and there is no reason why it should not do so if it be carried out correctly and with due attention to the special conditions which obtain here—the cost of the materials will be more than covered by the money value of the benefits directly traceable to their use, be these in the form of increased crop, improved frames, or greater immunity of the bushes from pests and blights. Even if the direct money return only equals and does not exceed the expenditure, manuring is justified on the ground that it is increasing the capital value of the estate.

RECENT TOURS.

Chief Scientific Officer.

Touring in the Dooars was continued from May the 20th. The Toorsa-Jainti, Dina-Toorsa, and Nagrakata districts being visited in turn. In the Toorsa-Jainti district considerable areas of tea had been very severely damaged by hail and in some cases beyond all hope of repairing the frame-work of the bushes without resorting to very drastic pruning. The Chief Scientific Officer took the opportunity of pointing out the value in such cases of making suitable manurial applications to increase the wood-producing capacity of the bushes. In this district he gave an address at the bungalow of the sub-district Chairman on the subject of pruning which was attended by nine planters. In the Dina-Toorsa district he addressed a meeting of seventeen planters on the same subject and visited several gardens. Many of the gardens in this district have a light sandy soil which appears to favour attacks of root fungus. On the 29th he proceeded to the Nagrakata district. Most of the soils of this district are on the Red Bank and it is to be noted that deteriorated tea on this soil is very liable to Red Rust. A very severe attack of Red Rust was noticed on a particular garden. It is easy to locate the disease at this time of year (June) owing to the fact that the red fruiting bodies are now in evidence on the stems, and the yellowish colour of the leaves of such shoots as are badly attacked is also an additional indication of the presence of the disease. Red Rust is a sign of weakness in the bushes and the first step to take is to invigorate them by means of good cultivation and to leave on the outsides of such bushes only such branches as grow vigorously. There is no likelihood of outside shoots which are weakened by Red Rust being of any value in producing vigorous flushes. They should be removed so that all strength is directed into such stems and branches as remain, and when the bush as a whole has been

strengthened outside branches of a really strong type can be built up again. It is particularly desirable to remove all outside branches which have a trailing habit. Sections which are badly attacked by Red Rust should invariably be manured liberally and should receive all the encouragement which it is possible to give them to enable them to throw off the disease. An address on pruning was given at the Nagrakata Club on the 3rd of June. Fifteen planters attended it.

On June the 4th the Chief Scientific Officer returned to Calcutta and left on the 15th for the Dam Dim district. On one of the older gardens of this district the observations which have been made above with regard to the desirability of removing trailing outside branches may be repeated though in the latter case the tea was considerably younger. Throughout this tour the question of loss of surface soil by wash has been carefully considered, and the Chief Scientific Officer took the opportunity of seeing as much terrace work as possible. Some very good work is now being done to repair washed slopes. It has been begun many years too late unfortunately, but it is now being carried out extensively, and it may be considered to be as important as any work done on tea gardens. The policy which is generally pursued is to terrace slopes in a thorough and complete manner, piece by piece as opportunity occurs, leaving the rest of the garden without any protection whatsoever from the wash which has been damaging them for so many years. A point which calls for emphasis is the importance of carrying out some temporary scheme for preventing wash in cases of gardens which have never been terraced or contour drained but where the management has awoken to the necessity of preventing further loss by wash. It would be a sound policy to grow a series of contour lines round such unterraced slopes with *Tephrosia candida* which serves excellently as a temporary means of preventing excessive wash. An arrangement of this kind would go a long way towards preventing further serious loss by wash pending the time the slope could be properly dealt with. This recommendation requires the careful consideration of Dooars planters. It is extremely difficult to terrace well tea which has been planted in square or triangular arrangement with no

reference to the slope, and it is only when terracing combined with replanting is being done that symmetrical terraces can be made. If the terraces are really good and are horizontal there is no objection to replanting tea on terraces with the planting so arranged, though if slopes are being merely contour drained and bunded the planting should always be along contour lines of the slope and not in square or triangular arrangement. The Chief Scientific Officer gave an address on manuring, in the Dam Dim district, which was attended by eighteen planters and on the same subject in Chulsa attended by twenty-eight planters. On the 28th he left for Calcutta. On July the 7th he left for Tocklai. On the 25th of July he arrived in the Terai and gave an address at Longview Tea Estate on the 26th instant at which there was an attendance of six planters and another at the local club on the 29th, which was attended by eight planters.

The soils of the Terai have not been studied so closely as those of other tea districts. Dr. Mann made no mention of them in the Tea Soils of North East India and apparently hardly a sample of soil from the district has been analysed. The Chief Scientific Officer could indeed obtain no figures from the gardens he visited. The use of manures other than those locally obtainable has not yet extended to this district and without figures of analysis it is difficult to make any unqualified announcement as to the manurial requirements of the soils of the district. The soils are generally sandy in type but not all are so. It appeared that in certain cases drainage might be defective, and there were indications on several gardens that lime was required to correct acidity of the soil.

The Chief Scientific Officer was in Darjeeling from the 3rd to the 8th of August. He visited the Chairman of the Darjeeling Planters' Association, and he and the Mycologist gave a joint address to a general meeting of the Darjeeeling Planters' Association at the Club on the subject of pruning, manuring, and spraying in connection with the prevalence of pests and blights in the gardens of this district. This was followed by a discussion. On August 9th the Chief Scientific Officer returned to Calcutta.

Mycologist.

The Mycologist left Tocklai on the 20th of May for Nazira where he stayed with the Superintendent of the Assam Company. Accompanied by the Scientific Officer to this Company he visited a number of gardens. He had the opportunity of meeting most of the Company's managers. On the 24th he left for Panitola where he stayed with the Scientific Officer of the Jokai Company. On the 26th the Mycologist visited Dibrugarh, leaving for the Doom Dooma district on the 28th. In Doom Dooma he visited many gardens and also discussed spraying with many planters whose gardens he was unable to visit.

The primary object of the tour was to advise planters with regard to spraying and to observe methods at present in use with a view to improving them if possible. It is highly probable that spraying with solutions which have a fungicidal and tonic action will very soon be added to the general routine of tea culture in Doom Dooma. The application of spray fluid to large areas is a recent innovation in the cultivation of tea, and it is only to be expected that the work is not at present carried out as thoroughly, or as economically as it will be when more experience has been gained. The application of spray fluids requires at least as careful supervision as pruning, and unless the work is properly supervised a great deal of money will be wasted and unsatisfactory results obtained.

It must be remembered that the efficiency of most spray fluids depends on the formation of definite amounts of chemical substances. The formulæ are not prescribed at random but are the result of careful chemical research. If the instructions given from time to time in the publications of this Department are not accurately followed the best results cannot be expected. If it be impossible to give the necesssary attention to the manufacture of spray fluids it would be far more economical to buy ready made mixtures such as Woburn Bordeaux paste although the cost be higher.

Spraying on a large scale is a new departure in tea culture and good supervision is at present essential if successful results

are to be obtained. Later on, when the subordinate staff has learned how to carry out the work properly, supervision will not be of such extreme importance. The success of spraying in the culture of other crops leaves no room for doubt that if carried out properly it will be successful in tea, and indeed actual results have already demonstrated its usefulness.

It is satisfactory to note that there is a large increase in the area under green manures in upper Assam. Some planters find it possible to grow green crops over two-thirds of the total area of their gardens without seriously interfering with other operations. Good crops of *Crotolaria striata*, Mati kalai, Soy beans, Cowpeas, Daincha, Arhar dal, and Boga medeloa were observed. If a good green crop is to be ensured the soil must be properly prepared for it. It is generally waste of time to sow small seeds on clods of earth. The soil must be broken up fairly smooth.

Where it was not possible to hoe in the green manure at the proper time sickling may be resorted to. This is not so good as hoeing in the green crop at once but a sickled green crop is better for the soil than no green crop at all.

On the 3rd of August the Mycologist met the Chief Scientific Officer at Darjeeling for the purpose of discussing the application to the special conditions which obtain in the Darjeeling district of recent developments in tea culture in the plains. On the 8th a joint address was given to the members of the Darjeeling Planters' Association. After the Chief Scientific Officer had dealt with the questions of pruning, manuring and cultivation, the Mycologist gave a brief description of the recent improvements in the machinery and methods of spraying. Some specimens of modern spraying machines and spray fluid preparations kindly lent by Messrs. Shaw Wallace & Co. were exhibited.

The climatic conditions of high elevation gardens are such that no matter how good the manuring, pruning and cultivation, disease caused by fungi and other vegetable organisms will always be present and will always require active treatment. The conditions on different gardens differ so widely that the subject could only be dealt with in a general way in the address but it is hoped

that planters themselves will apply the general principles to their own particular gardens.

As the whole question of spraying will be discussed in detail in the pamphlet which will be published shortly, it is not necessary to publish here that part of the address which deals with the subject. The Scientific Department has lately been in communication with the leading manufacturers of spraying machinery, and is in a position to give full particulars of all the best machines. The Mycologist will give careful attention to any schemes submitted to him and will discuss them fully in the light of his observations on spraying in this and other districts.

After the meeting the Mycologist left for a tour in the district.

NOTES.

A new caterpillar pest of tea :—Watt and Mann, in 'The Pests and Blights of the Tea Plant' p. 179, 2nd Ed. 1903, mention one butterfly (*Pareba vesta*) whose larva feeds on tea.

We are now able to record another, *Delias aglaia* Linn., a member of the family *Pieridae*. Larvae in the last stage were received from the manager, Dhekiajuli tea estate, Assam, on January 26th, 1914. They pupated on January 29th, and the moths emerged on February 17th.

Larva :—The caterpillar is dark red, with the head, last segment, and legs black. The prolegs and claspers are black on the outside. On the head, and on each segment except the last, is a bright yellow transverse band, and there are five longitudinal rows of conspicuous yellow hairs, one row dorsal, two rows dorso-lateral, and two rows lateral. These hairs show a tendency to be infuscated. The full caterpillar is about an inch and three-quarters in length.

Pupa :—The pupa is reddish, turning black. The head end is bluntly rounded and has three well pronounced tubercles. The thorax has a very pronounced median longitudinal keel, and along the abdomen are three longitudinal rows of tubercles. The pupa case is attached to the leaves, and is about three quarters of an inch in length.

Imago :—The body is black above, suffused with white, the white predominating beneath. The fore-wing above is black with a row of seven irregular greyish spots close to the outer margin, one greyish white spot towards the centre, and an irregular greyish white band across the wing nearer the base. The underside of the fore-wing has the same markings, but much more distinct. The hind wing above has the same black ground—colour on the outer half with five dirty white irregular spots near the outer margin, and one towards the centre of the wing. The basal half of the

wing, however, is greyish white before, merging into yellow behind, with a very faint red band across the base bordered by a faint purplish band. The underside of the hind wing is very striking. It is bright yellow, with a bright red band across the base. Along the outer border of the red band is a black band, and from this a network of black stretches across the yellow ground to the outer margin, which is also black. The butterfly measures 2½ to 3 inches across the expanded wings.

This butterfly is very common in the tea districts, but it has not been recorded as attacking tea before, and in this instance the damage done was but slight.

On the 15th of May caterpillars of this butterfly were collected at Tocklai on Rogamulla. (*Lauranthus sp.*). They pupated on the 19th and emerged as butterflies on the 27th, spending 8 days in the pupal stage in May against 19 days in January.

E. A. A.

A pest of stored tea dust.—On the 28th of May last a sample of tea dust was received from the Cinnamara tea factory of the Jorhat tea company. The dust had been kept in an airtight tea sample tin of the usual description, and when the tin was opened the dust was found to be infested with minute white insects which burrowed into the tea on being disturbed. On examination these insects were found to belong to the family *Psocidae*, sub-family *Atropinae*. They seemed to be feeding on the tea, but beyond being interesting from an entomological point of view are probably of little importance.

The use of lime.—J. Hendric, B. SC., F.I.C., in a paper published in the 'Journal of the Society of Chemical Industry' makes the following statement :—

> "It is estimated that the average loss of lime per acre per annum in this country, (*i.e.* United Kingdom) is not less than 500 lb. of carbonate of lime. This quantity of carbonate of lime, or 280 lb. of quick lime per acre per annum, should therefore be applied to all cultivated

land, or in other words, at least 1 ton of commercial burnt lime of good quality or $1\frac{3}{4}$ tons of good quality chalk or ground limestone, should be applied once in seven years merely to maintain the quantity of lime in the soil."

The rate of loss of lime from the soil in the tea districts of North East India is probably more rapid than under the more temperate conditions prevailing in the United Kingdom and consequently it may be necessary to apply even larger dressings of lime to maintain the quantity in the soil Many soils in the tea districts suffer from a deficiency of this substance and a still further quantity would have to be applied to those soils when it is desirable to increase the total amount of lime present.

Green manuring.—An interesting and suggestive article on green manuring by C. M. Hutchinson, M.A., E.B., Imperial Agricultural Bacteriologist and S. Milligan, M.A., B.SC., Imperial Agriculturist has appeared as Bulletin No. 40 of the Agricultural Research Institute, Pusa.

C. O. P.—1100—16-10-14.